Detecting the Signature of Planets at Millimeter Wavelengths

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The study of planet formation mechanisms is a central part of our search for an understanding of the origin of the Earth and Solar System. The motivation to study the environments of planet formation has become more intense since the discovery of the first giant planets around nearby solar-type stars using the Doppler planet-detection technique. One of the most intriguing results of searches for exoplanets (and a challenge to the new theories of planetary formation), is the discovery that the formation process gives rise to considerable diversity. Surveys of young stars at infrared and millimeter wavelengths show that most exhibit thermal emission from small heated particles distributed in disks (Proto Planetary Disks "PPDs"), with properties similar to those of the young Solar System. Models of their spectral energy distributions (SEDs) and imaging indicate disk sizes of tens to hundreds of AU. These dusty and gas-rich disks are believed to provide the material for proto-stellar sources, as well as the reservoirs of mass for the formation of planetary systems. Although there is now abundant evidence for the existence of circumstellar disks around young low-mass stars, our understanding of the detailed properties of disks, in particular at distances associated with planet formation (< 30 AU), is still in its early stages. With the combination of high angular resolution and sensitivity in new millimeter experiments (e.g., ALMA and LMT), we will be able to image the detailed structure of nearby disks, and detect the gaps and inner-holes (both spectrally and spatially) created by the clearing of material during the planet formation process.